TISA (Time-Space Averaging) Update

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TISA Team:

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SSAI

13th CERES-II Science Team Meeting
Newport News, VA, April 27-29, 2010

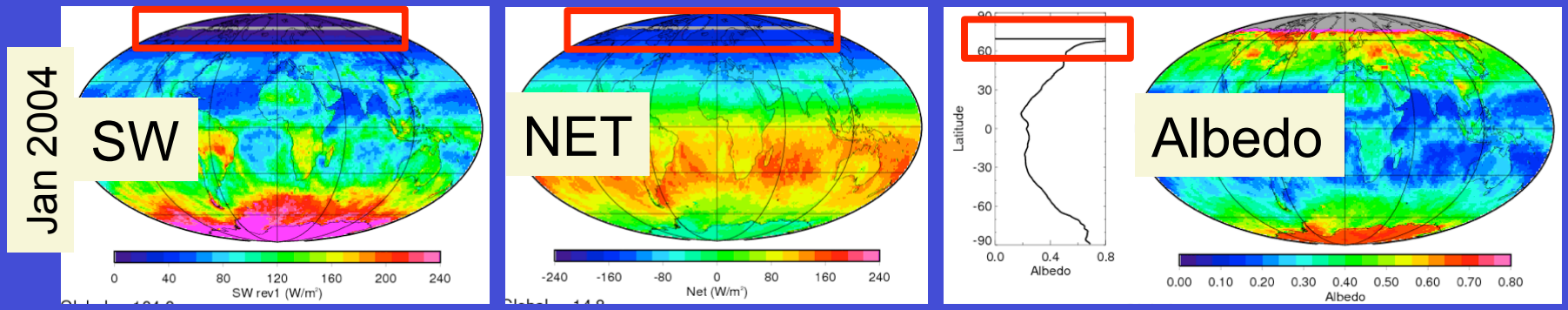
Outline

- ISCCP-D2like Ed2 products
- CERES Ed2.5 lite products
- GEO temporal averaging regional monthly and seasonal improvements over Terra or Aqua only sampling
- MTSAT calibration update
- CERES Ed3 ordering tool
  - Live Demo

CERES Ed2.5 lite products

- Edition3 CERES instrument calibration processed with Edition2 algorithms (clouds, ADMs, etc)
  - All known instrument artifacts removed
  - Will use Solar Radiation and Climate Experiment (SORCE) incoming solar as well as the Edition 3 products (~1361 Wm^{-2})
- Designed to give users a quick look into the CERES Edition 3 product fluxes
  - Both SSF1deg (nonGEO) and SYN1deg (GEO) available
  - Terra product from Mar00 to Dec08, possibly to Feb 2010 as a 10-year dataset
  - Reduce parameter dataset, Monthly and Daily resolution
- Available on CERES prototype ordering tool as beta
  - Soon to be released as Edition 2.5 for publication
  - All 9 years can be ordered as one netCDF file on tool (0.6GB)

SW Terminator Regions and Twilight



- Edition2 there were ~4 terminator zones where the regional monthly SW was undefined because
  - No daytime measurements, but sun was above the shortly horizon, perhaps some days were dark others were lit
  - Measurements where the SZA>85° are undefined
- Edition3 will fill in the SW monthly means with the last measured zonal albedo multiplied by the SW incoming
  - All all-sky regions will have a monthly SW and albedo mean where the sun was above the horizon, albedo is a daytime parameter
  - Monthly mean albedo is undefined during polar night
- Twilight will continue to be added to the SW
  - Twilight is the refracted atmospheric reflected SW flux
  - Global contribution of twilight is 0.25 Wm^{-2}, regionally can be 0. 5 Wm^{-2}
  - Albedo not effected, even though some terminator regions will have SW>SW incoming

GEWEX-RFA TOA climatology (2000-2005) comparison

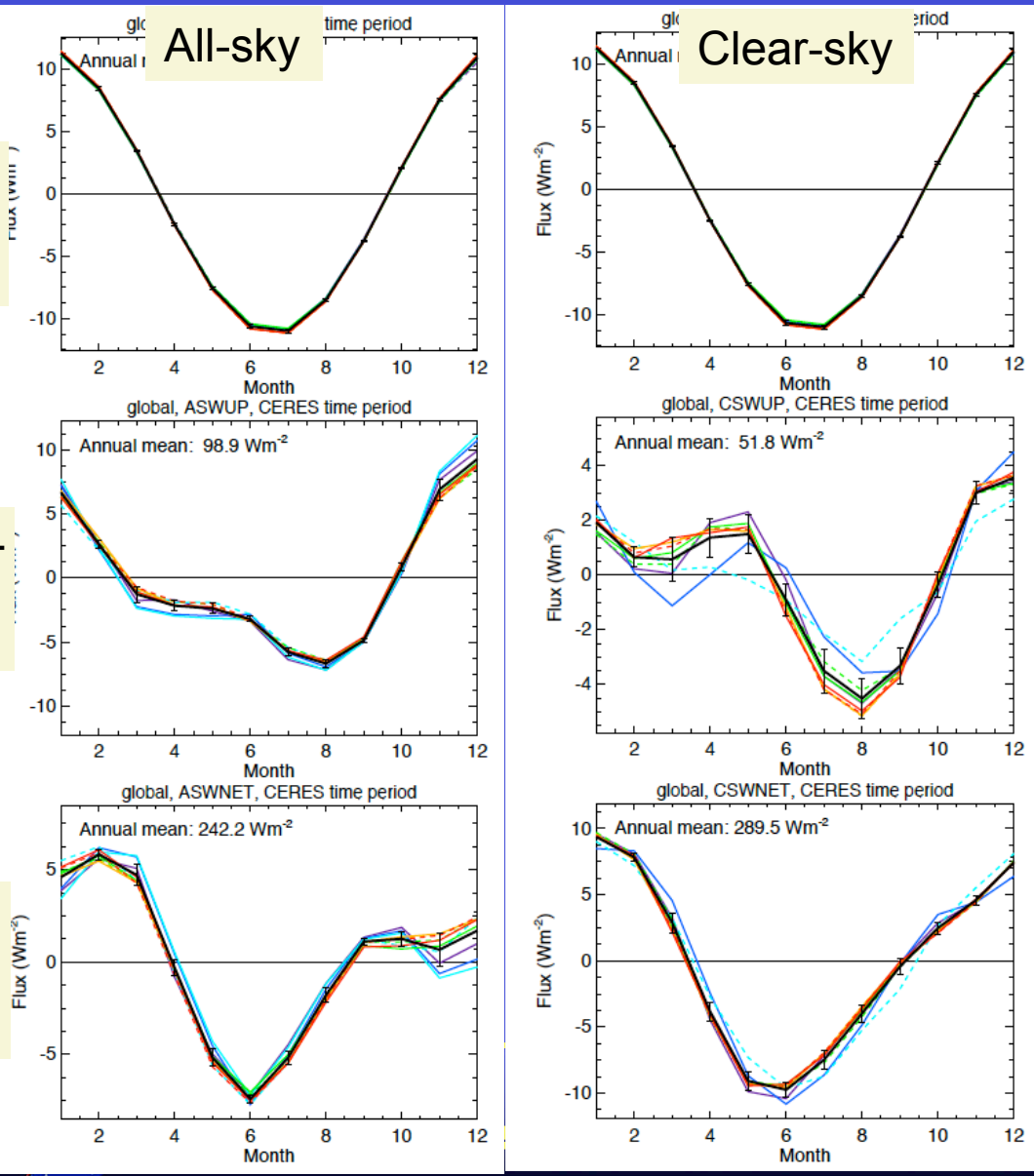
All-sky

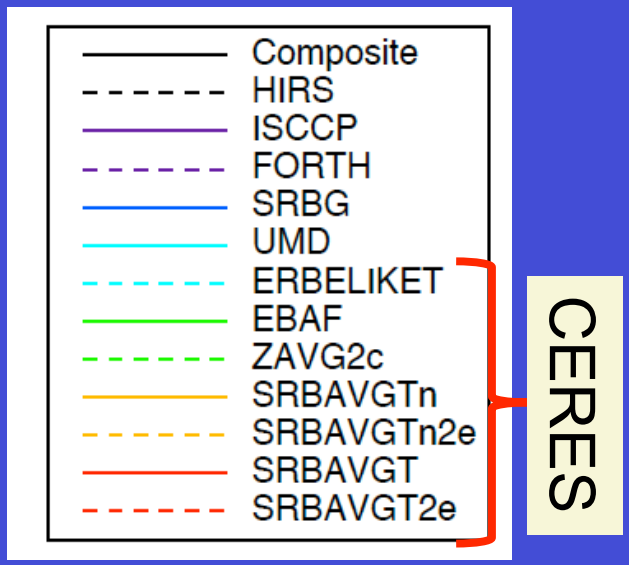
Clear-sky

SWdn

SWup

SWnet





- CERES TOA fluxes are line with other observed datasets
- GEWEX-RFA assessment determined that there is greater variability among modeled fluxes than observed

Courtesy of Laura Hinkelman

GEWEX-RFA Surface climatology (2000-2005) comparison

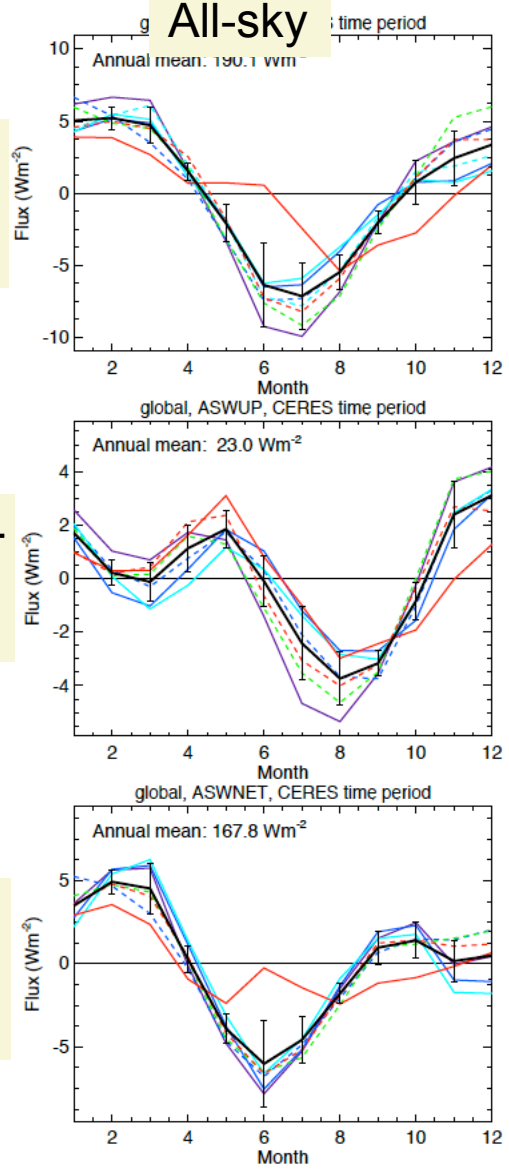
All-sky

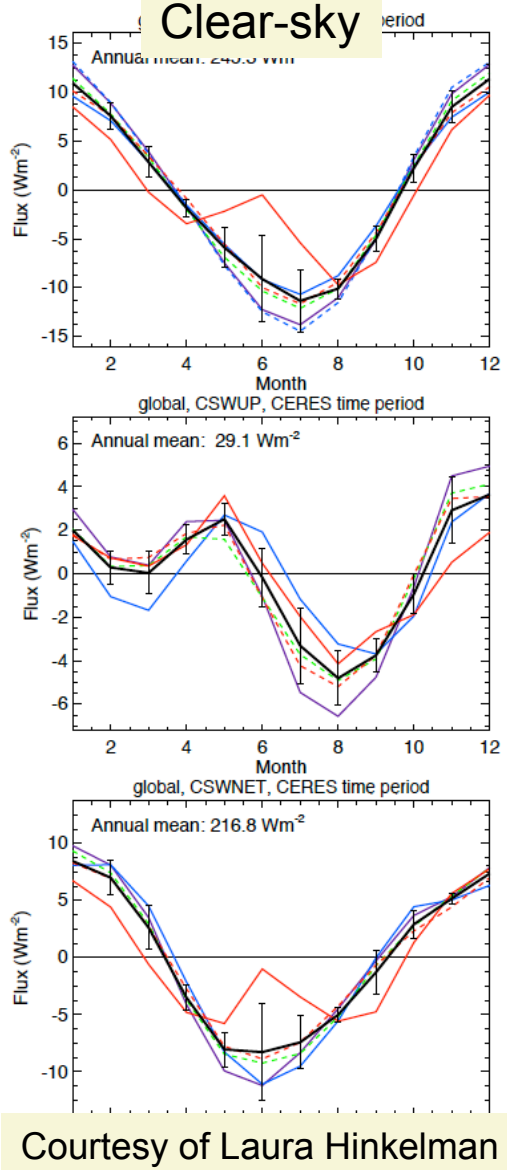
Clear-sky

SWdn

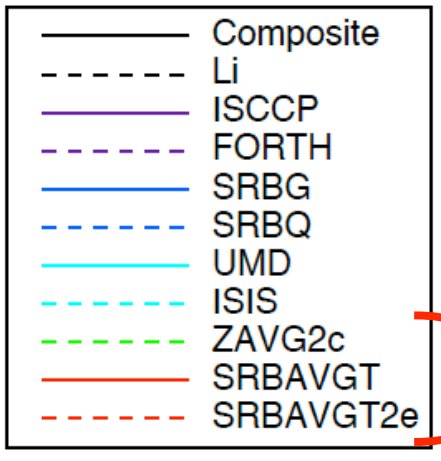
SWup

SWnet

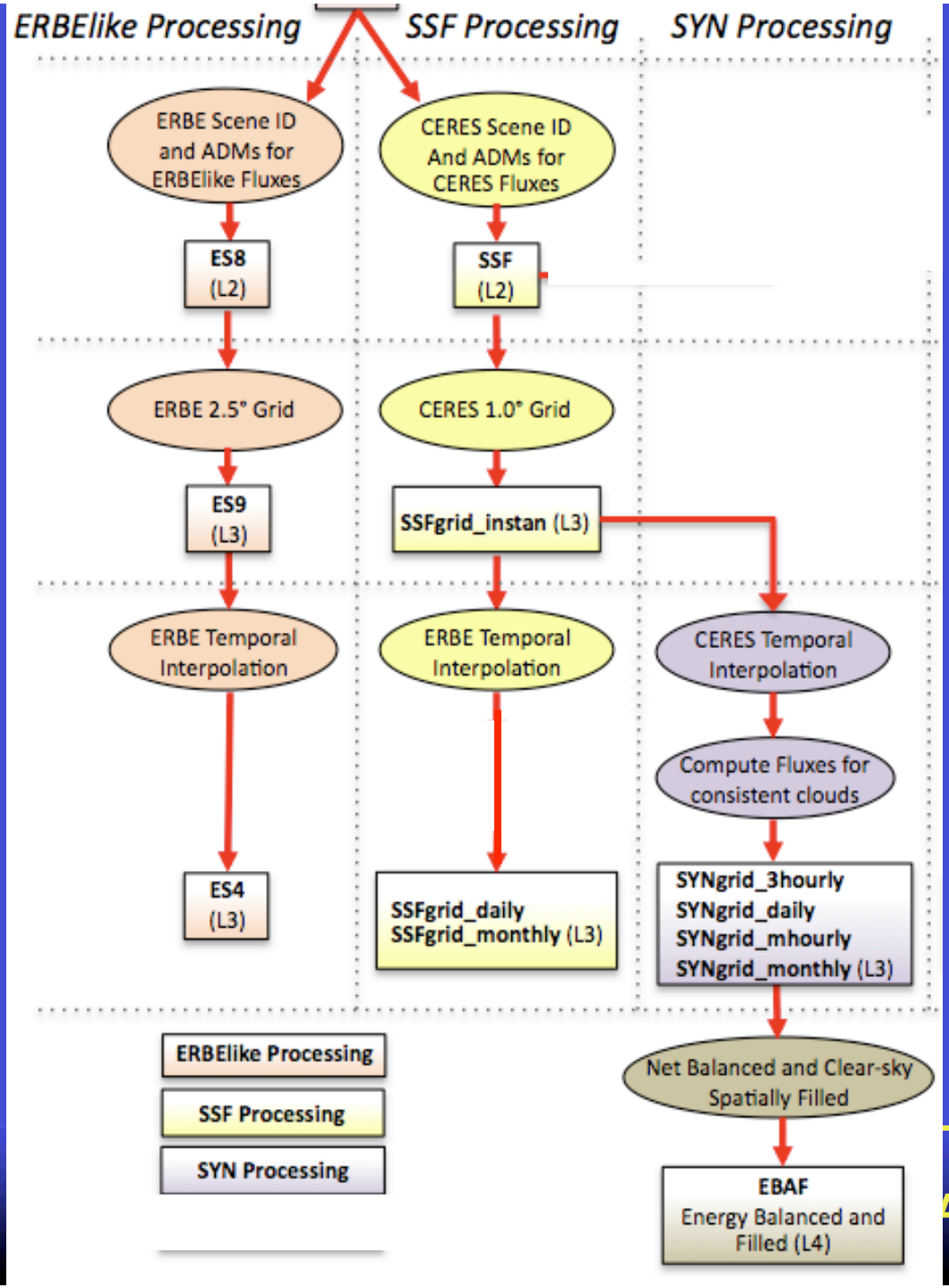




Courtesy of Laura Hinkelman



- Note SRBAVG Ed2D did bug in zonal averaging to derive global mean, the default zones were not interpolated (---) before averaging (terminator issues)
- SRBAVG Ed2E corrected the problem (...)
- Always good for more eyes to look at the data
- Ordering tool will help also



CERES Edition3 flowchart

- CERES temporal interpolation uses 3-hourly GEO cloud and fluxes in between CERES observations to derive daily means
- GEO derived fluxes have been normalized to CERES fluxes

GEO SW regional diurnal improvements

GEO SW regional seasonal improvements

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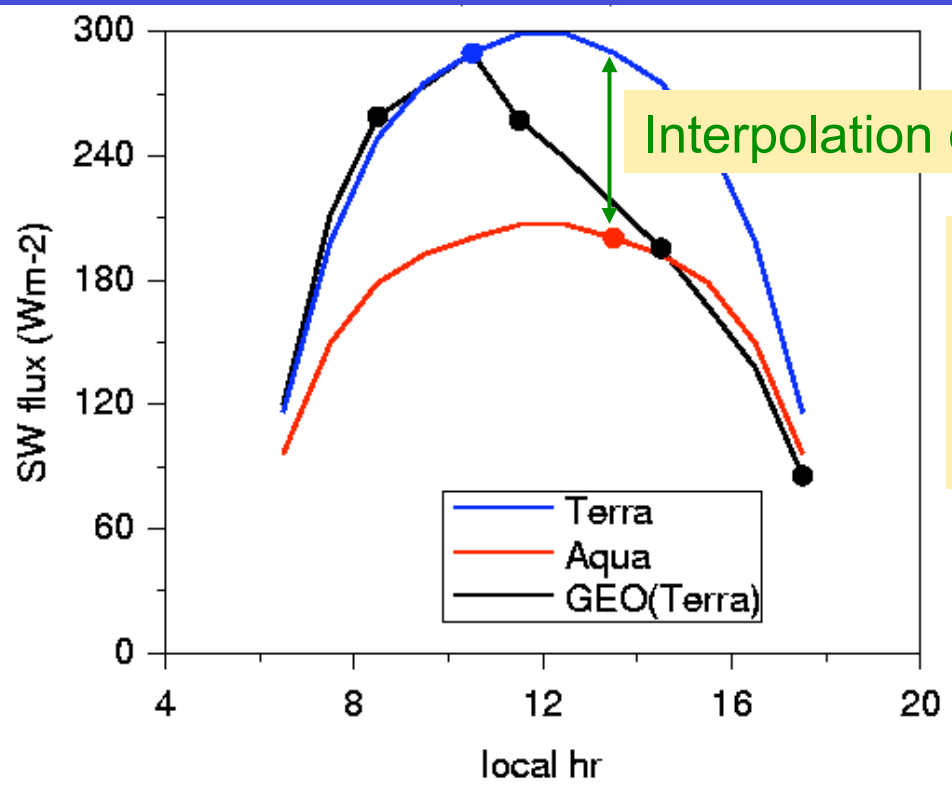
**SSAI, [a]NASA LaRC*

SW Diurnal Averaging

Convert instantaneous measured flux to daily mean flux

Example: Peruvian stratus region

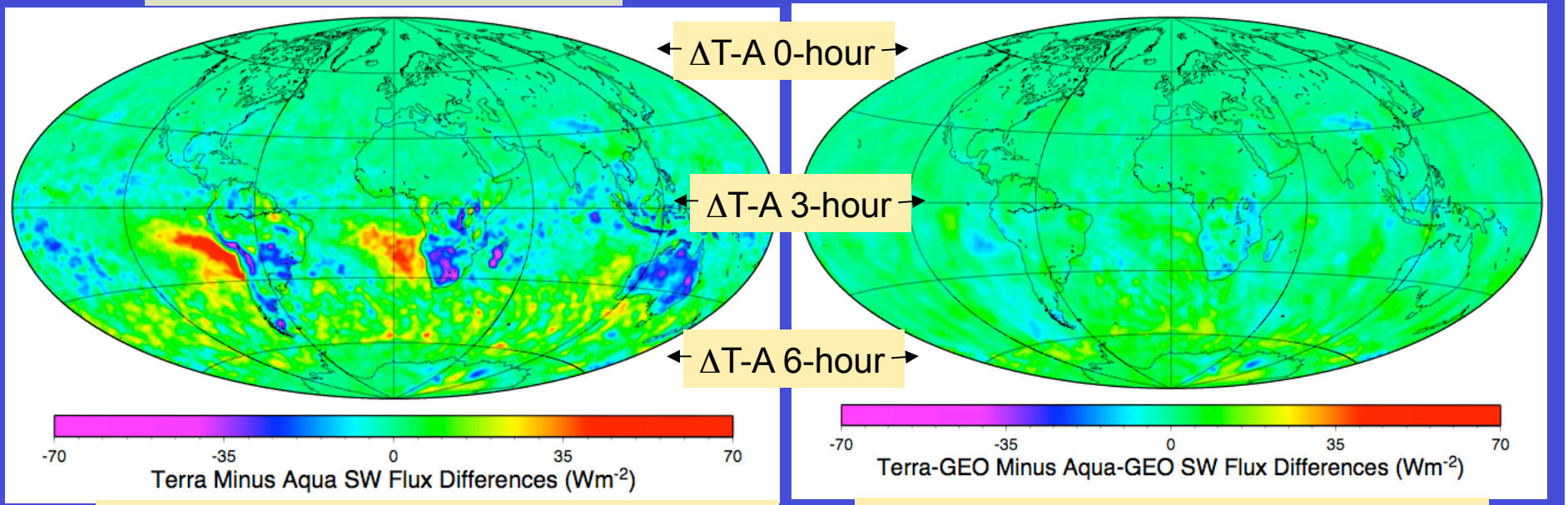


Daily mean (Wm-2)	
Terra	119.0
Aqua	85.4
GEO	102.3

Terra (10:30 LT) - Aqua (1:30 LT) monthly CERES SW flux differences Dec 2002

CERES only fluxes

CERES & GEO fluxes



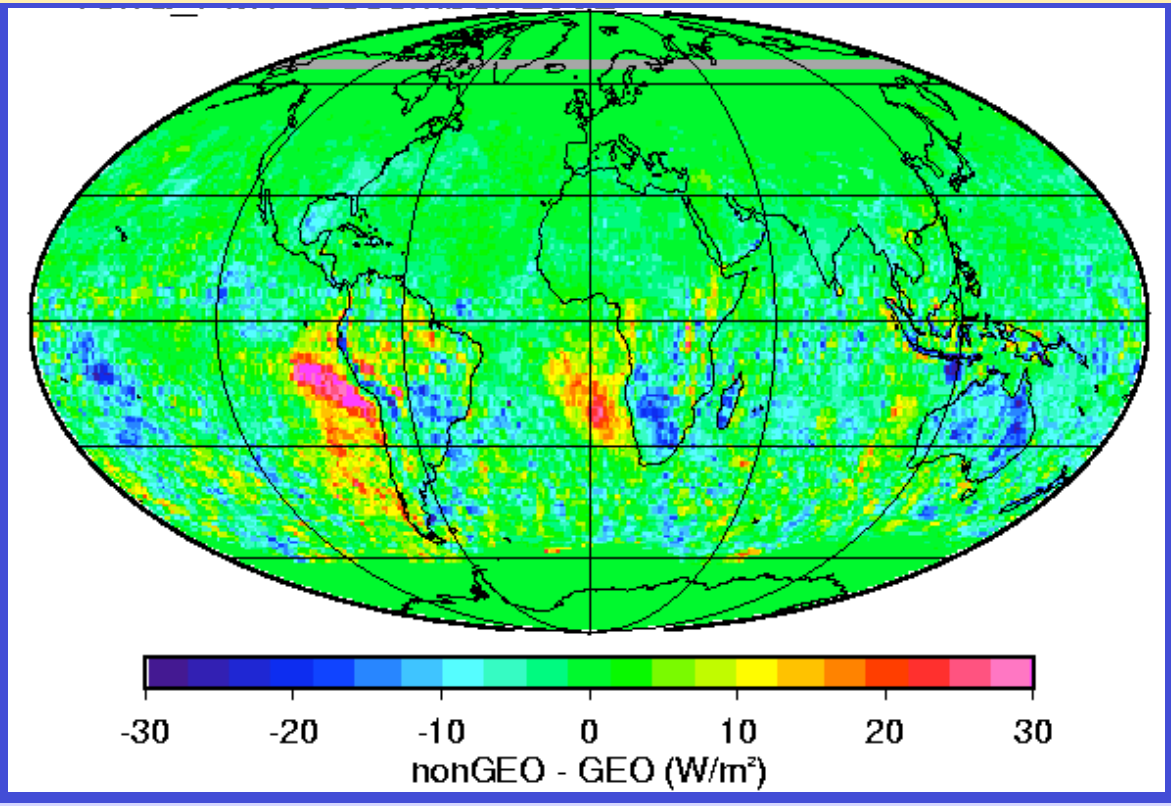
Regional rms=11.7 Wm^{-2} (11.1%)

Regional rms=4.6 Wm^{-2} (4.3%)

- Terra fluxes > Aqua fluxes over marine stratus regions (morning clouds)
- Aqua fluxes > Terra fluxes over land afternoon convection regions
- The merged GEO fluxes have removed the CERES sampling bias of the diurnal cycle

Terra nonGEO - GEO SW monthly mean Dec 2002

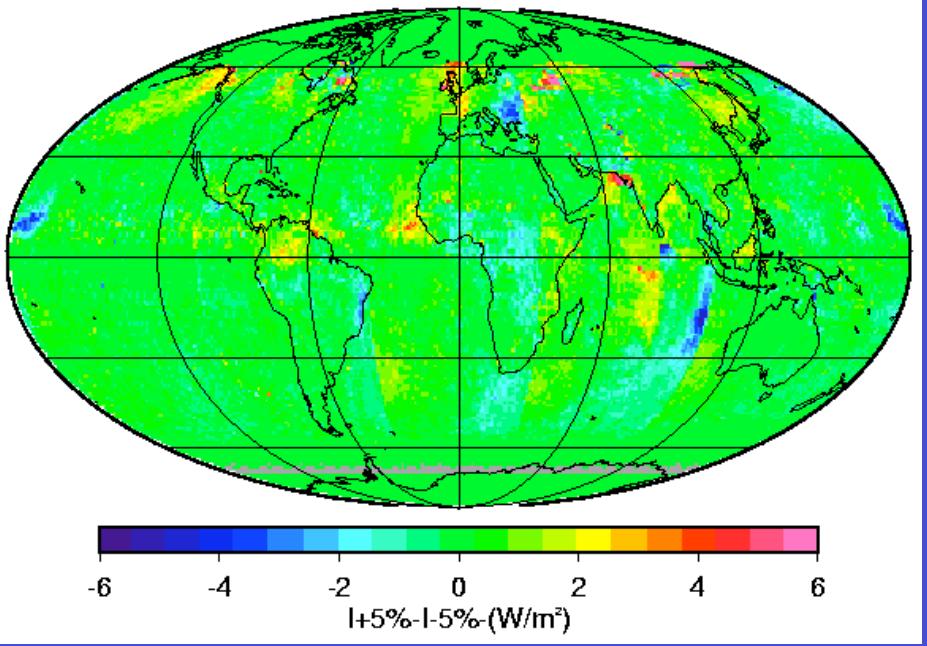
- nonGEO = CERES fluxes and ERBE (constant meteorology) temporal averaging
- GEO = CERES fluxes utilizing GEO fluxes for temporal interpolation



- Regional monthly differences can be > 20 Wm^{-2}
- Global bias is - 1.0 Wm^{-2}

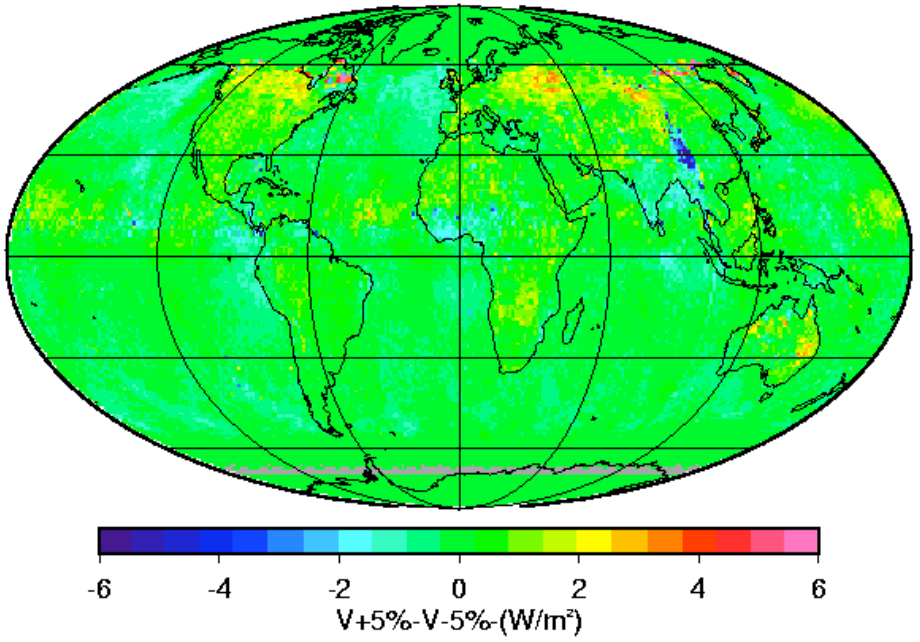
Change in Total-Sky TOA SW Flux due to artificial GEO calibration adjustments, July 2002

(IR+5%) - (IR-5%)



Bias=0.10%,rms=0.9%

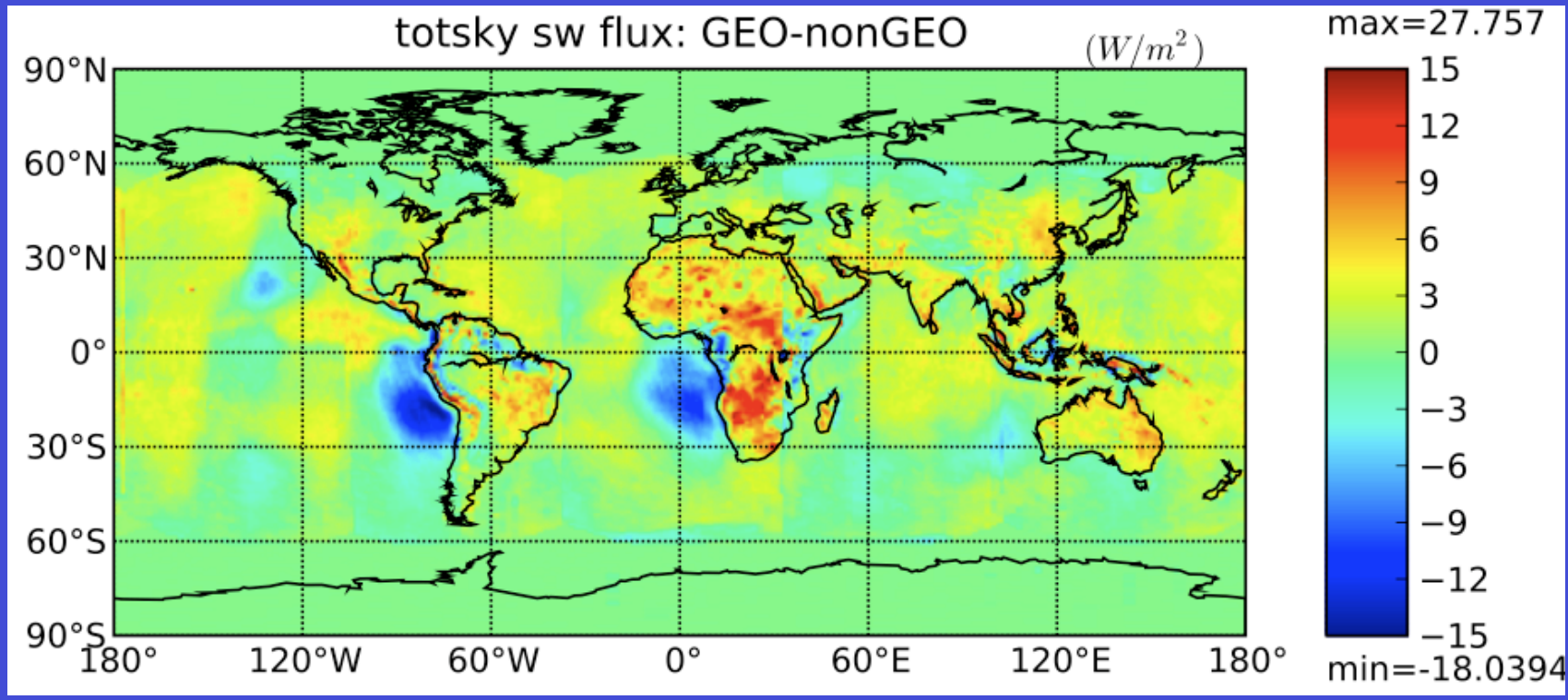
(VIS+5%) - (VIS-5%)



Bias=0.01%,rms=0.8%

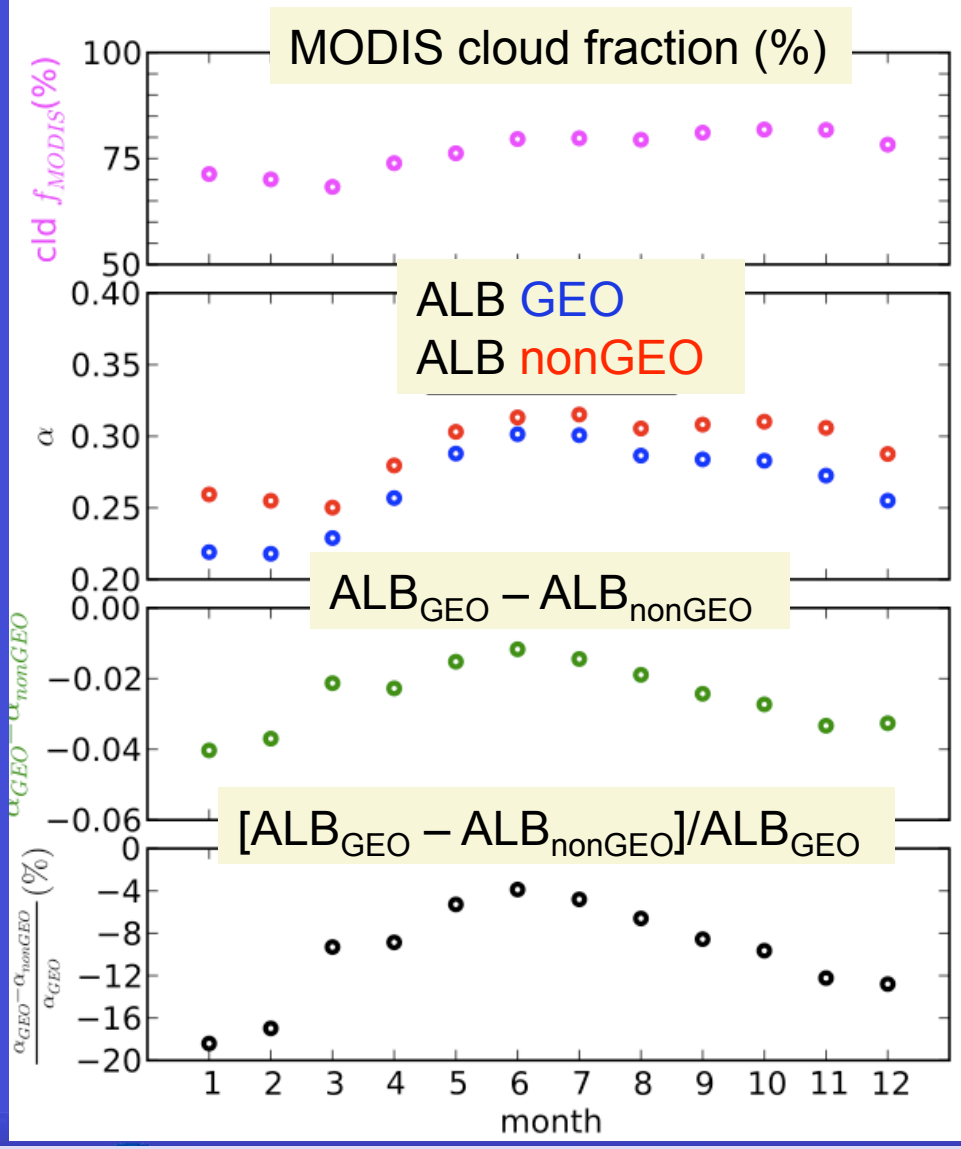
- Plotted differences are for 10% calibration change
- Actual GEO SW calibration uncertainty is 3-5% and LW is 1-2%
- GEO flux constrainment to CERES removes sensitivity to GEO calibration
- Even though MTSAT VIS is not well calibrated, it will not alter CERES calibration

Mean TOA all-sky SW Mar00-Dec08
SYN(GEO) – SSF(nonGEO)

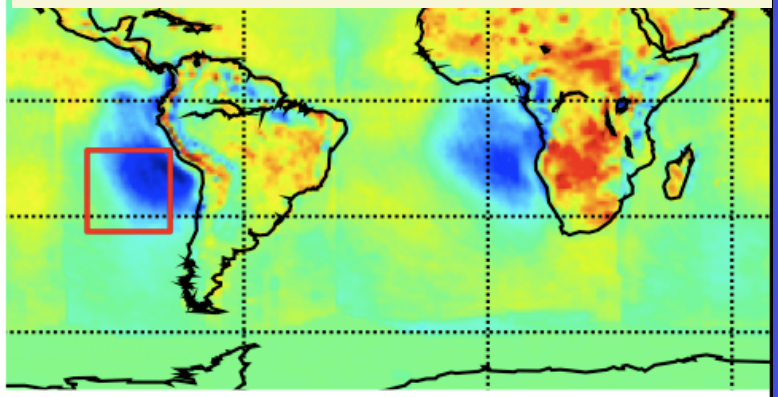


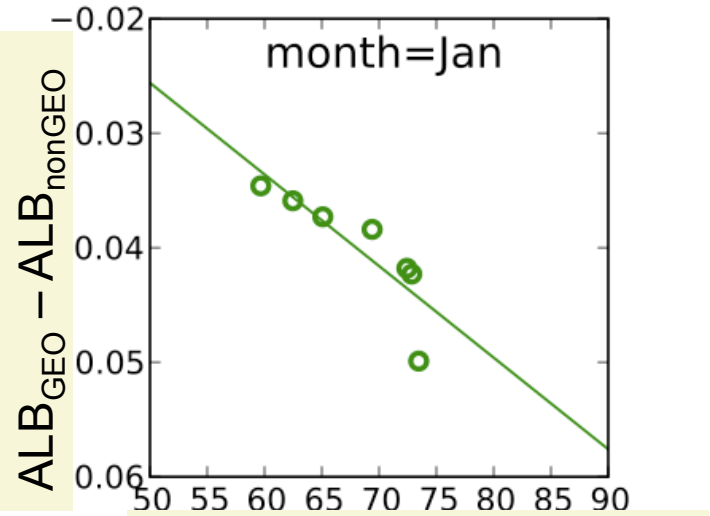
- Regional monthly differences can be > 15 Wm^{-2} even for an 8 year mean
- Global bias is - 1.0 Wm^{-2} get bias from Luscheng
- However some GEO artifacts are apparent

TOA SW all-sky seasonal cycle (maritime stratus)



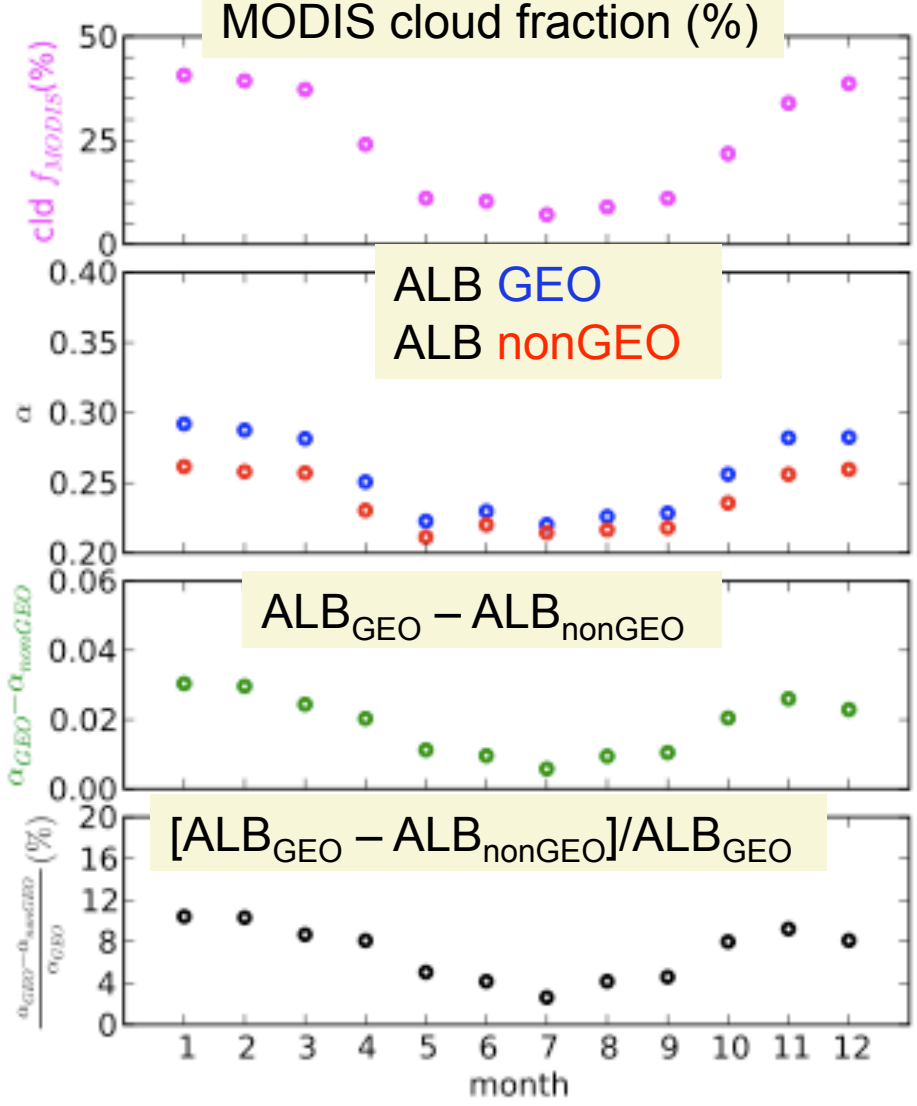
TOA SW GEO-nonGEO



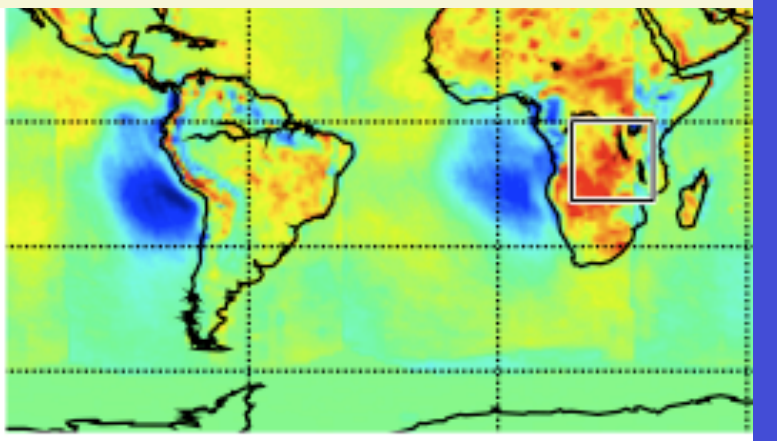


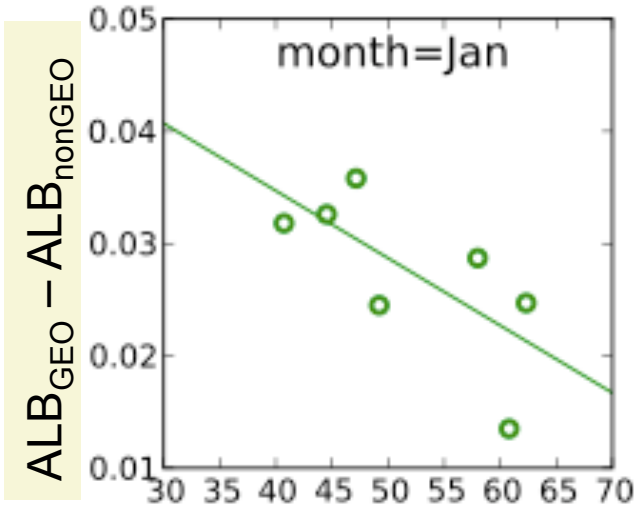
- Cloud fraction variability at Terra (10:30AM) times translate to albedo nonGEO diurnal variations
- The nonGEO seasonal cycle is dependent on how 10:30AM is representative of the diurnal mean

TOA SW all-sky seasonal cycle (land convection)



TOA SW GEO-nonGEO

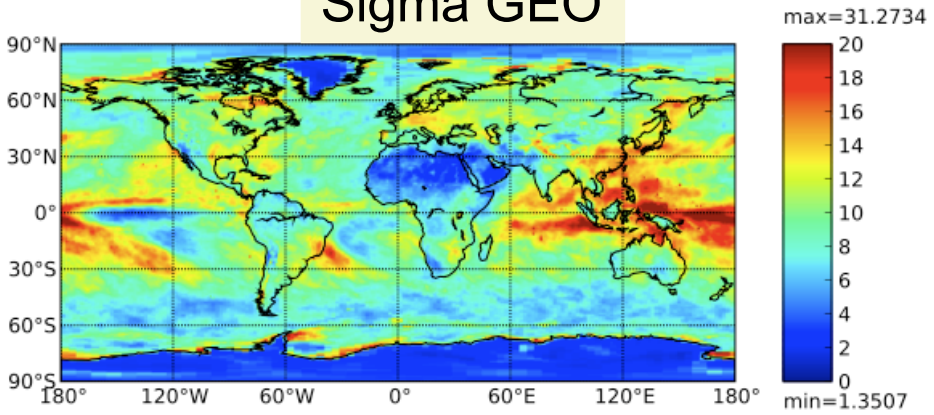




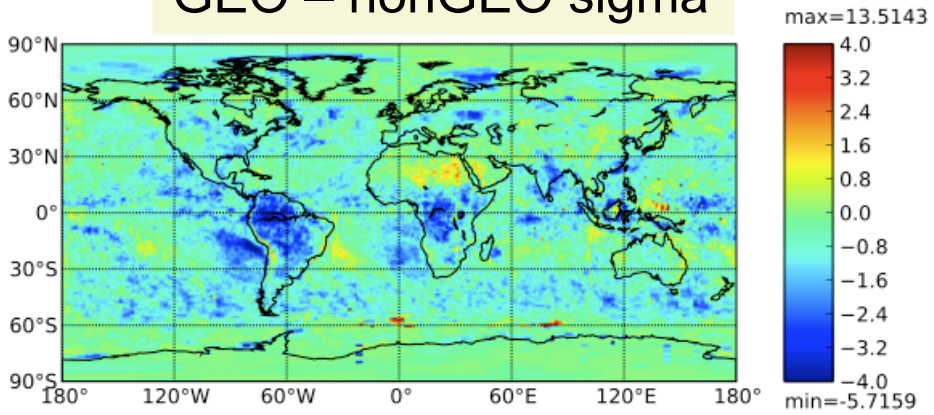
- Land afternoon convective regions with wet and dry season are insufficiently sampled at 10:30AM
- Constant meteorology at Terra (10:30AM) times has dampened the albedo seasonal cycle

TOA SW monthly sigma

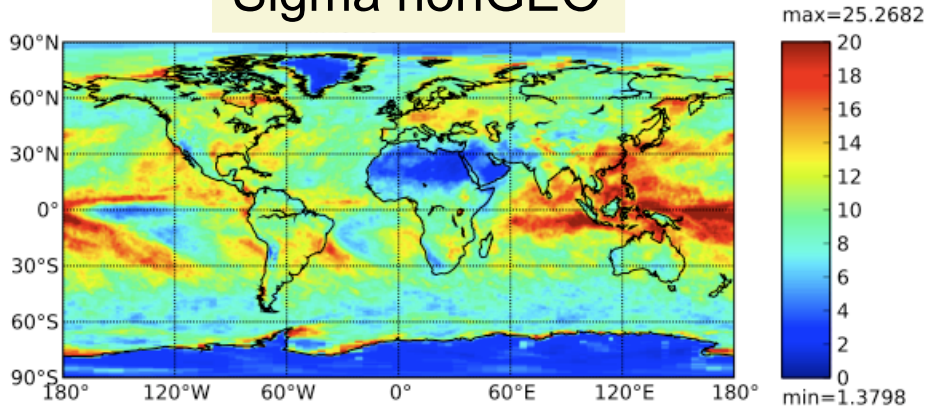
Sigma GEO



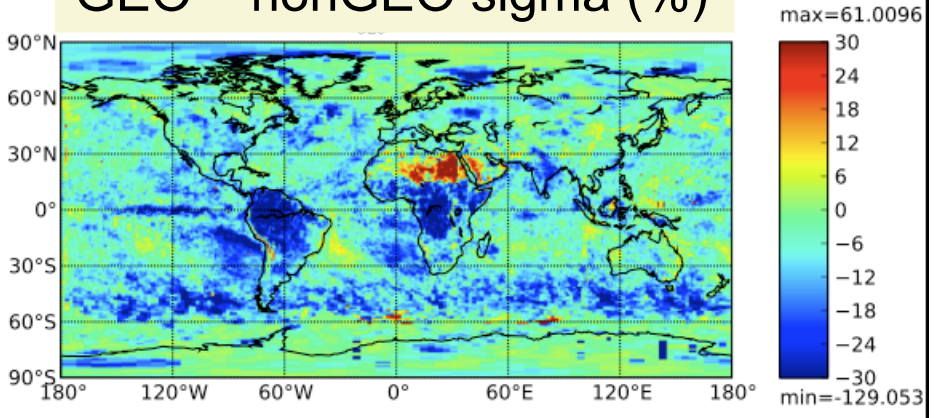
GEO – nonGEO sigma



Sigma nonGEO



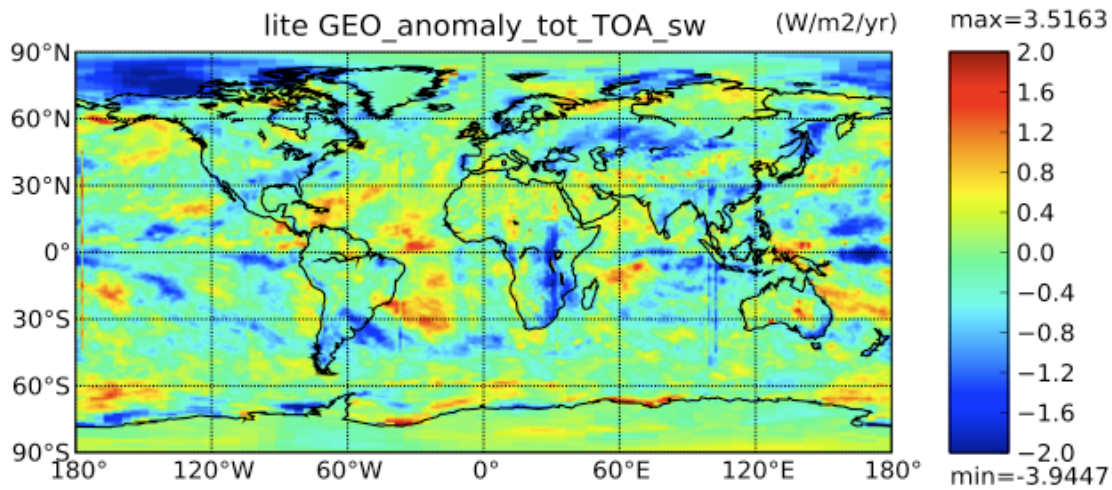
GEO – nonGEO sigma (%)



- For almost all regions the nonGEO SW monthly noise is greater than the GEO
- The uncertainty in trend detection will be greater in the nonGEO SW fluxes

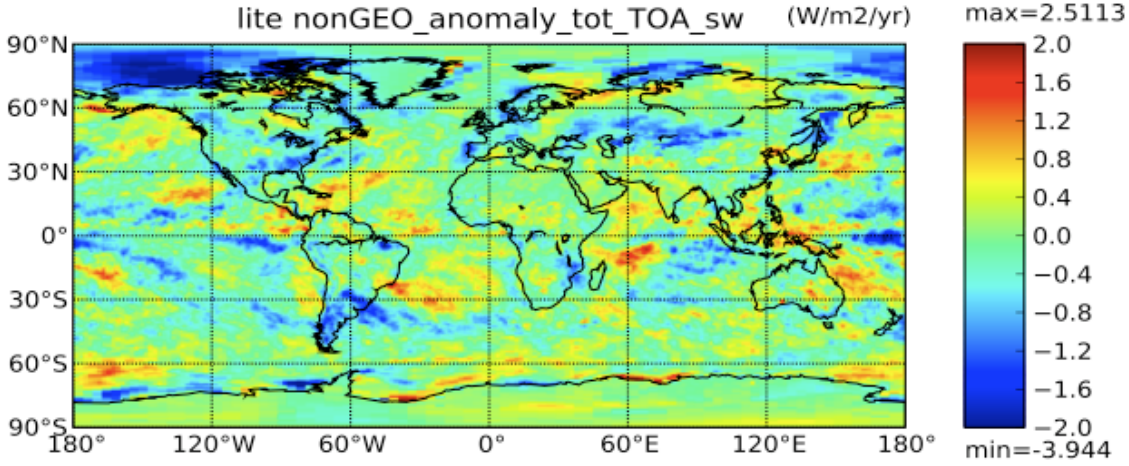
TOA all-sky SW 2000-2008 regional trends

GEO



$Wm^{-2}/year$

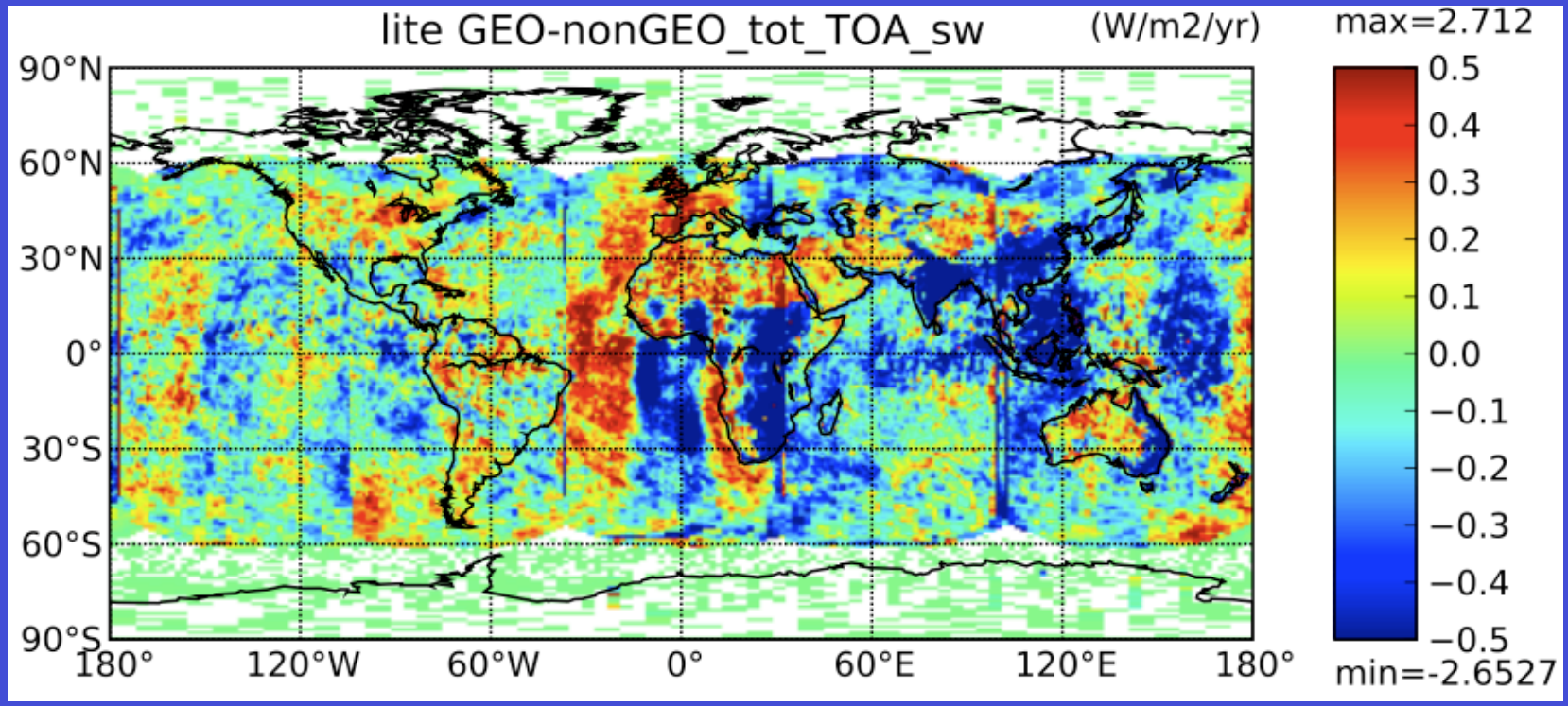
nonGEO



$Wm^{-2}/year$

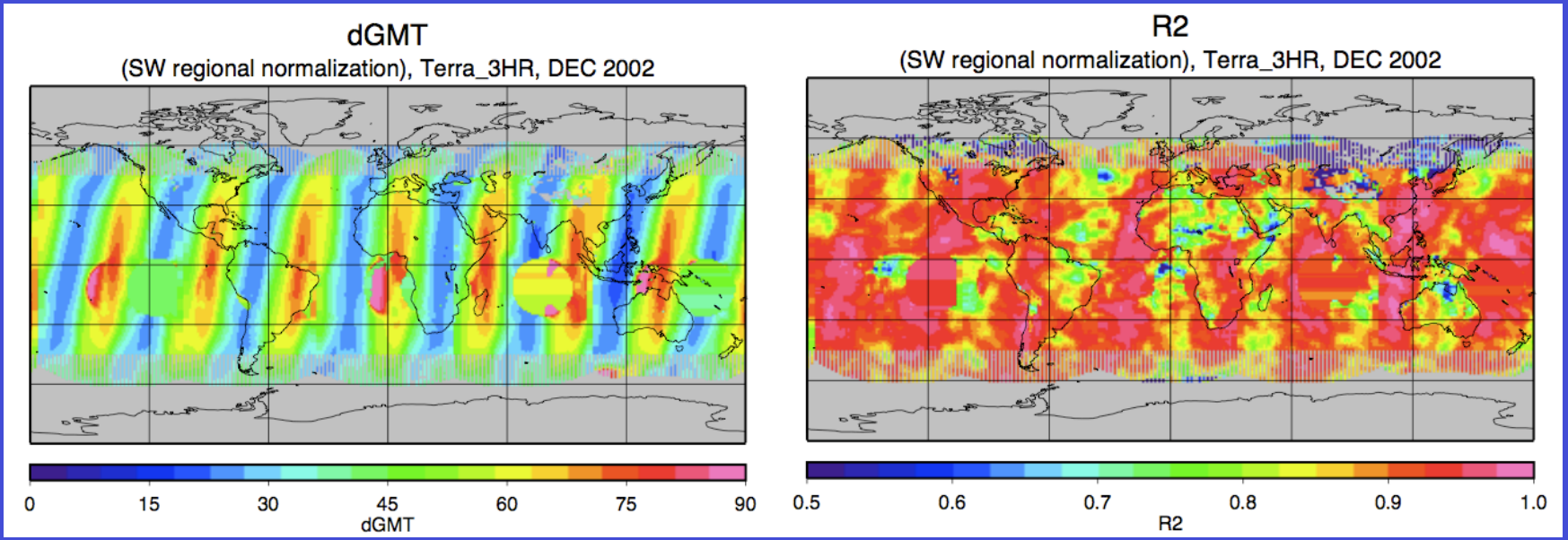
- Trends are very similar

TOA all-sky SW GEO –nonGEO 2000-2008 regional trends



- GEO-nonGEO trends are shown 1/4 the magnitude of the previous plots
- Clearly there are GEO artifacts where the SW normalization is stretched due to the 3-hourly GEO resolution

SW regional normalization



- Due to the 3-hourly GEO resolution, some regions are normalized where the GEO and CERES instantaneous fluxes are an 1.5 hours apart
- Changing meteorology will increase the noise of the normalization and may bias results
- Will look at 1-hourly GEO resolution to see the impact of the improvement weighted against processing 3x as many GEO images
- Will also look at combining GEO and nonGEO fluxes by scaling the GEO contribution as a function of regression RMS error to diurnal signal

MTSAT calibration update

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M. Nordeen, R. Raju
SSAI

"Healthy Team Context" Behaviors

Green " Cultivating "
You meet other's needs for feeling appreciated, care about them, seek shared interests and live high values.
(Emotion & Intuition)

Blue " Visioning "
You meet other's needs for realistic, optimistic futures and are 100% committed to your team's success.
(Logic & Intuition)

Intuited info.

Emotional deciding ← → *Logical deciding*

Sensed info.

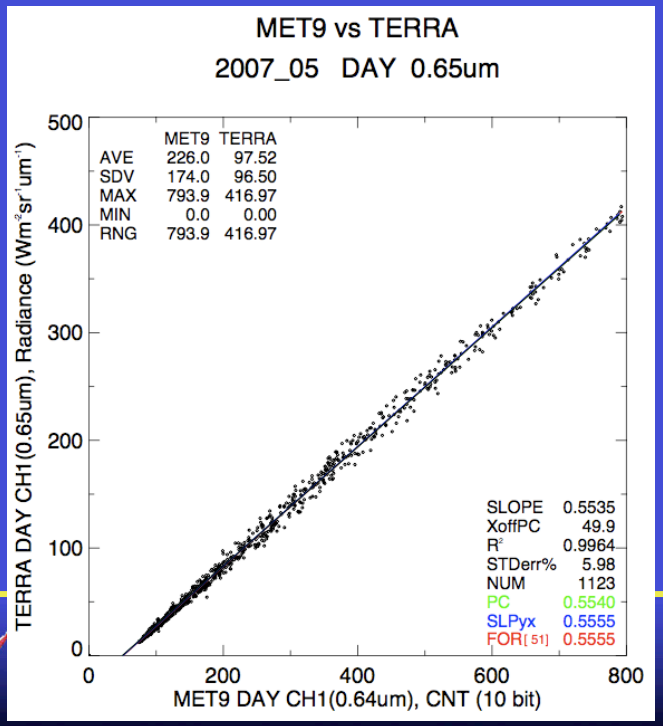
Yellow " Including "
You meet other's needs for feeling included, and demonstrate integrity by keeping your agreements.
(Emotion & Sensing)

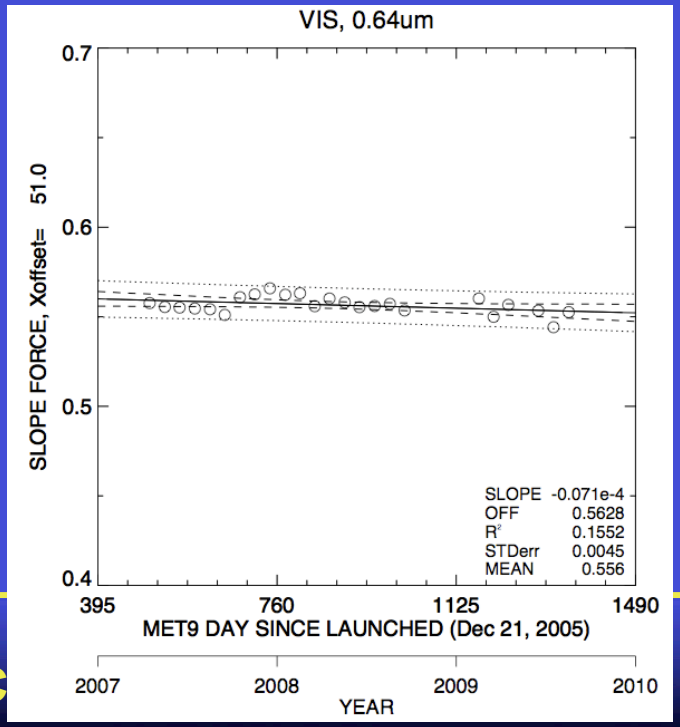
Orange " Directing "
You avoid Victim and Blamer and clarify others' expectations with clear RAAs.
(Logic & Sensing)

Behavioral competence in these four "Dimensions" sustains high performance team contexts.

GEO to MODIS Cross-Calibration Method

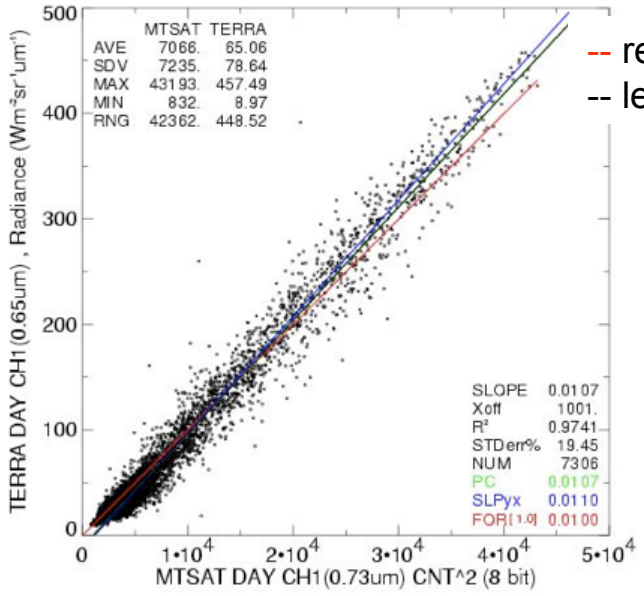
- None of the GEO visible sensors have onboard calibration
- Ray-match coincident GEO counts (proportional to radiance) and MODIS radiances averaged over a 50^2 km ocean grid near the sub-satellite point (±15° lat by ±20° lon area)
- Perform monthly regressions to derive monthly gains
- Compute timeline trends from monthly gains





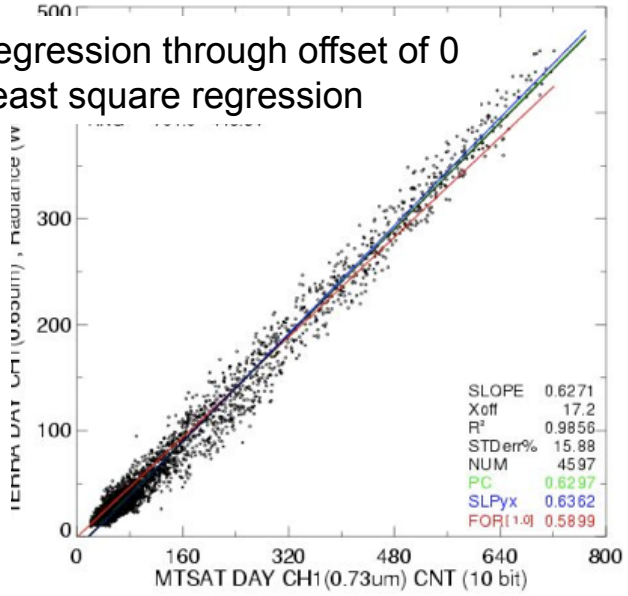
MTSAT-1R/MODIS VIS cross-calibration

MTSAT/Terra
April 2006, 8-bit

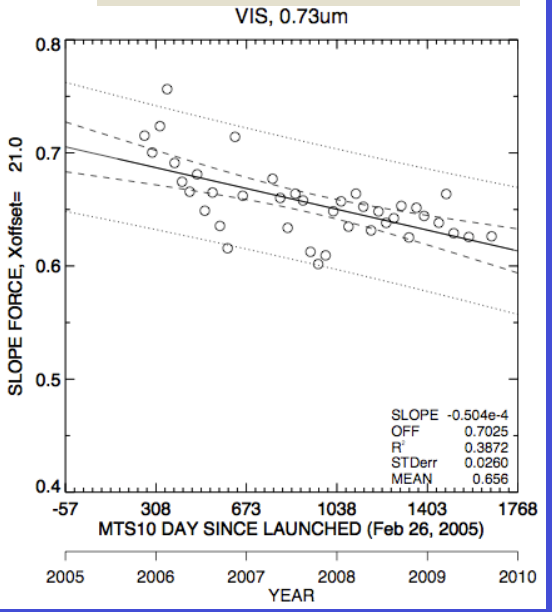


MTSAT/Terra
April 2008, 10-bit

-- regression through offset of 0
-- least square regression



MTSAT/Terra
2007-2009



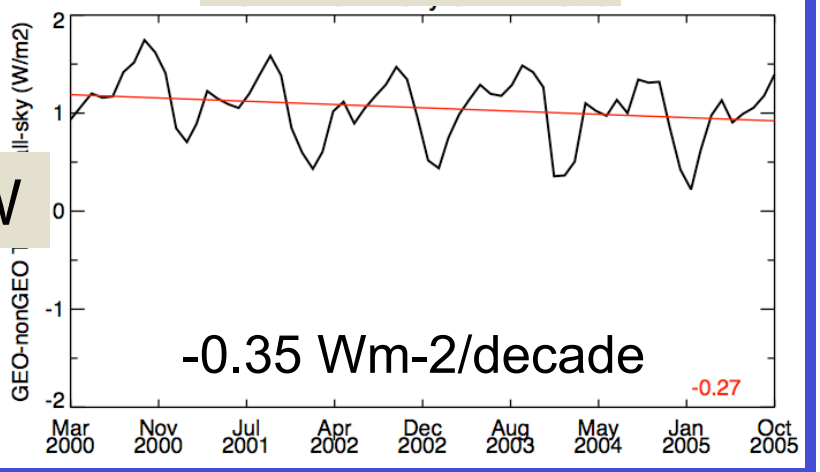
- Same ray-matching technique as the other satellites
- Note the departure from linearity in the low part of the dynamic range
- Whether 8bit count^2 HiRAD or 10bit linear HRIT images show nonlinear behavior
- Similar behavior for Aqua-MODIS, GOES-11 and VIRS
- MTSAT IR cross-calibration is typical of other GEOs, implying good navigation

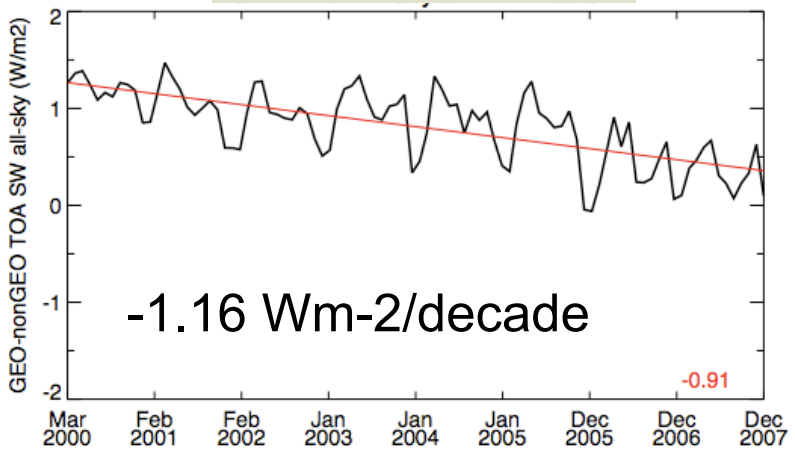
GEO-nonGEO SW, LW trends

Mar00-Oct05

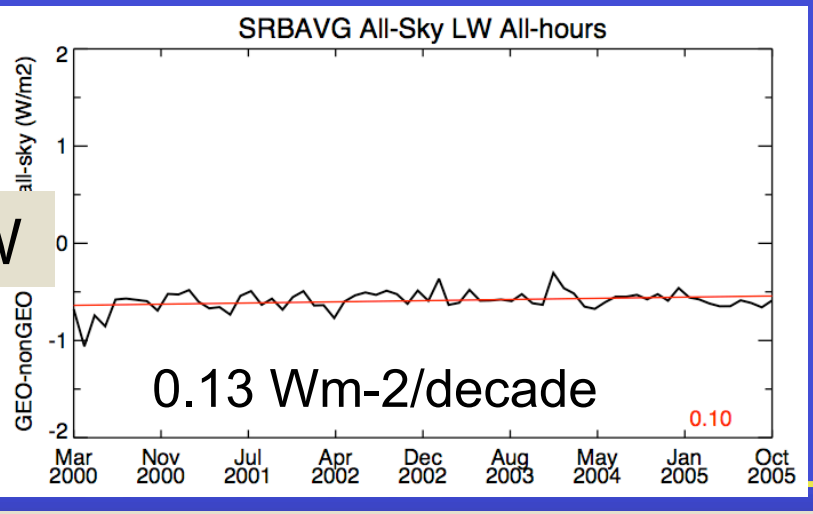
Mar00-Aug07

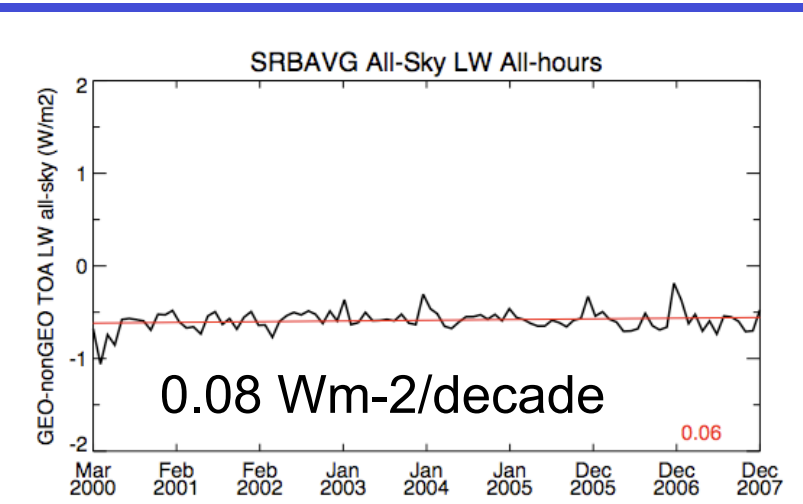
SW





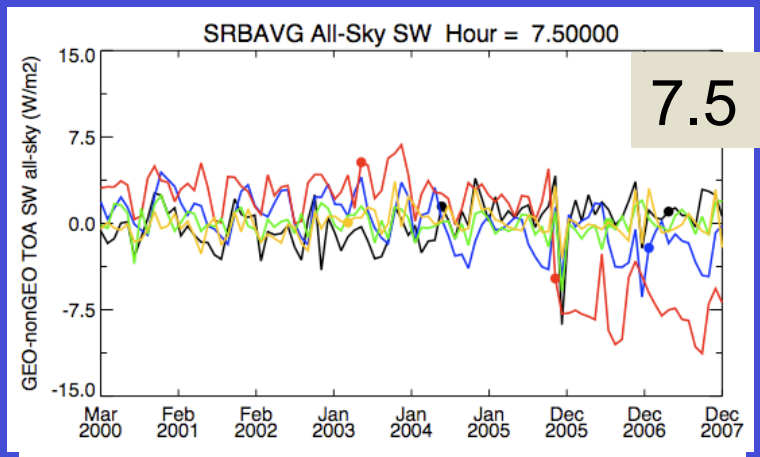
LW

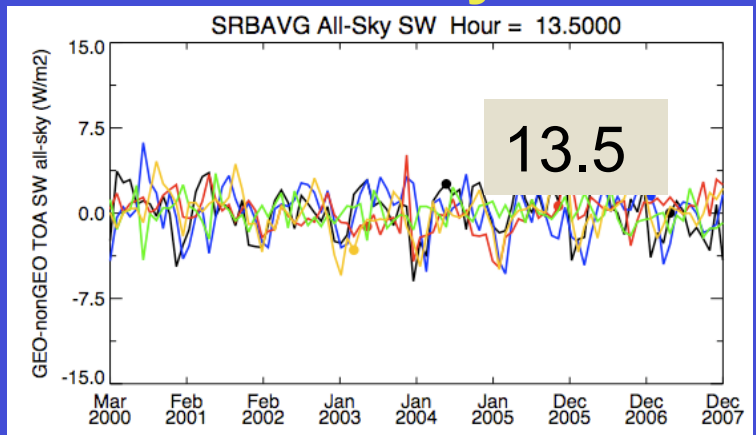


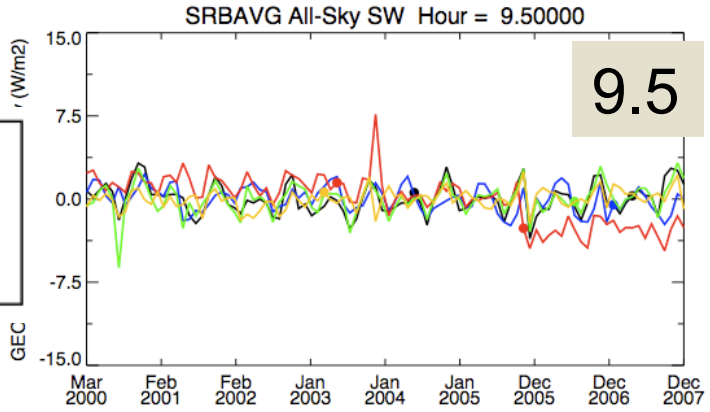


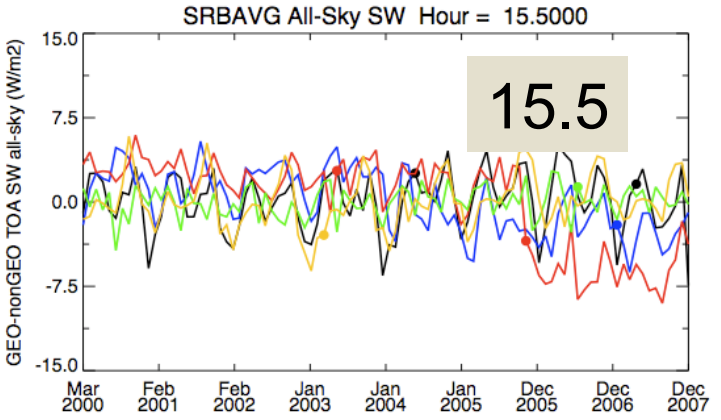
- Such a drastic change in the GEO-nonGEO SW trend prompted validation of SW normalization

GEO-nonGEO SW deseasonalized trends by local hour

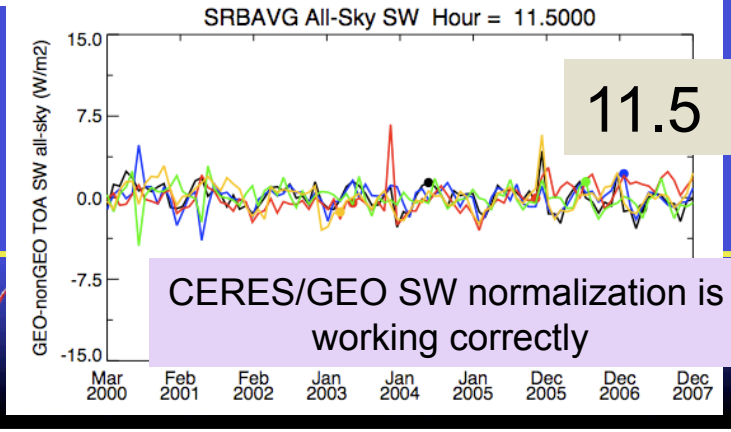


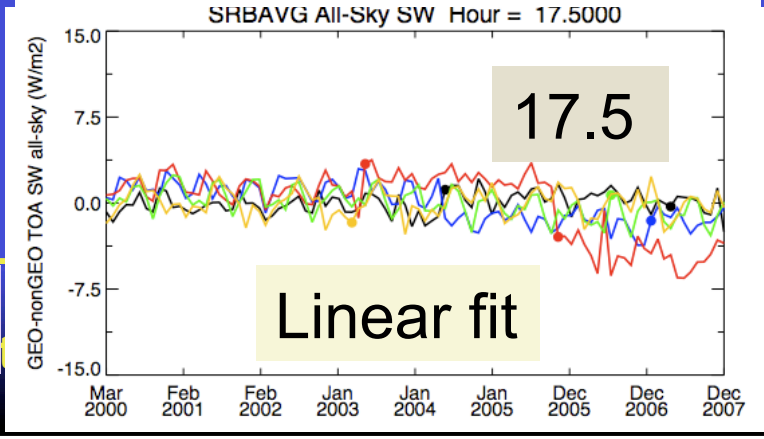






MET8
MET7
MTSAT
GOESW
GOESE

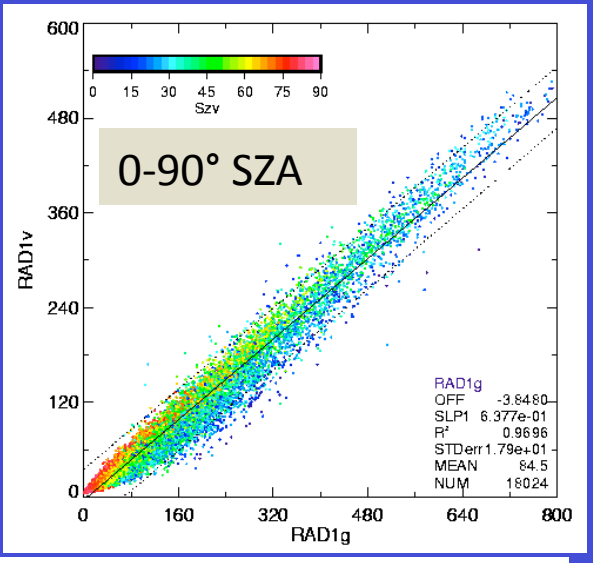




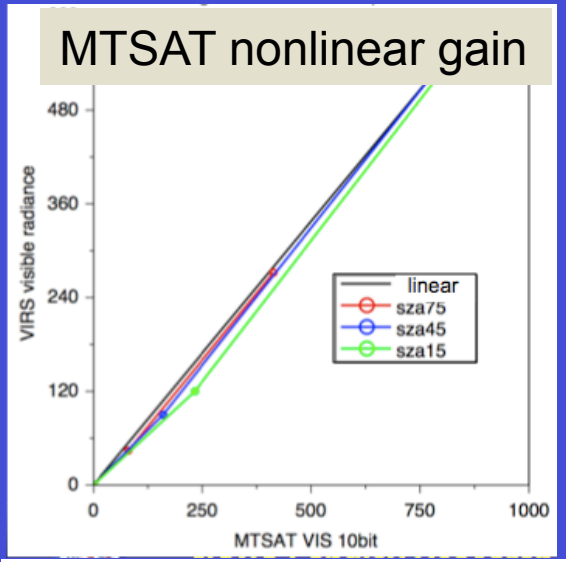
CERES/GEO SW normalization is working correctly

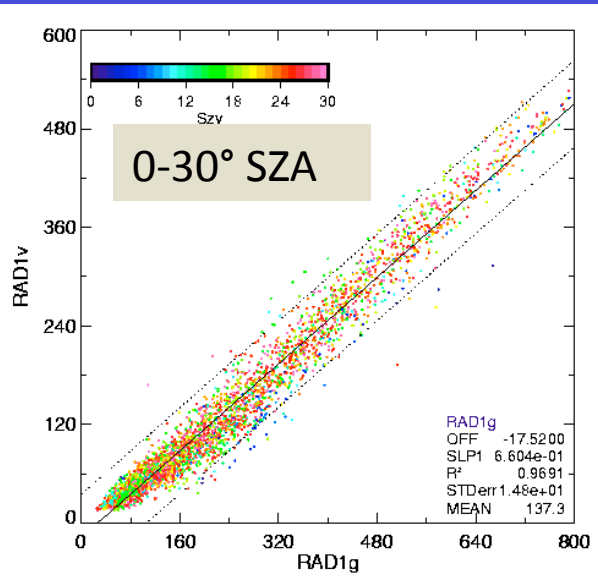
Linear fit

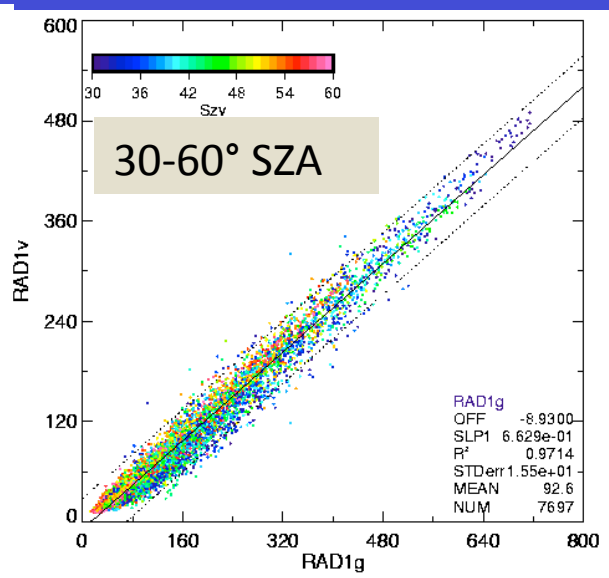
MTSAT/VIRS SEP07-MAR08

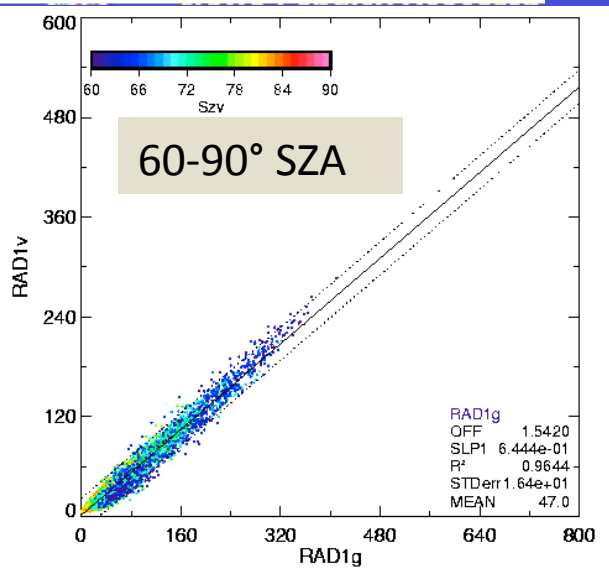


- VIRS is in a 47 day precessionary cycle observing all SZAs every 23 days
- Derive a nonlinear MTSAT gain as a function of SZA

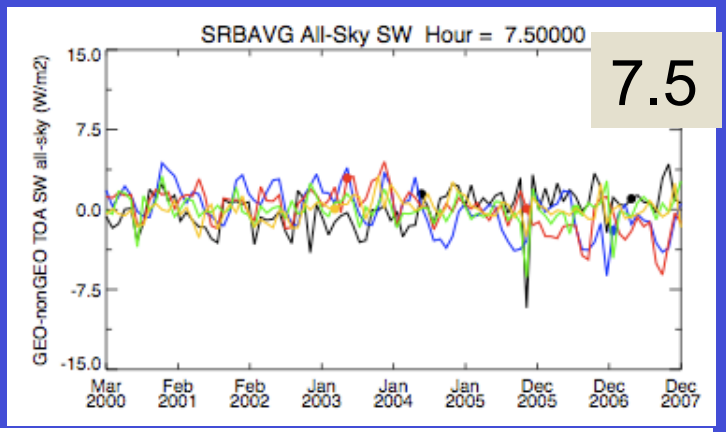


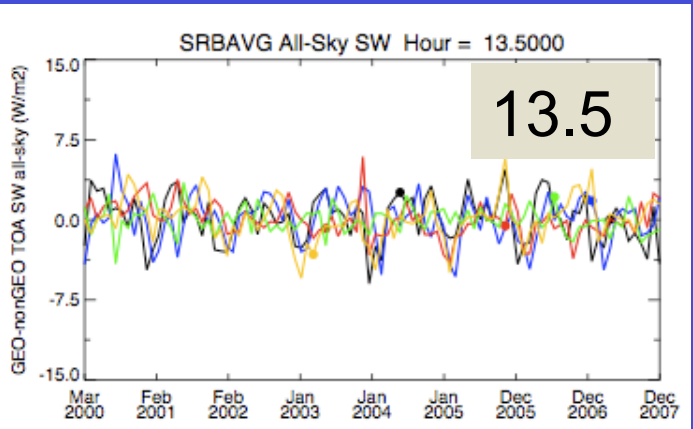


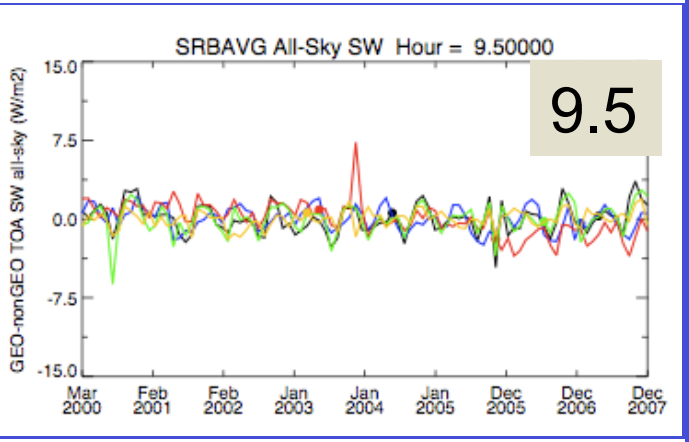


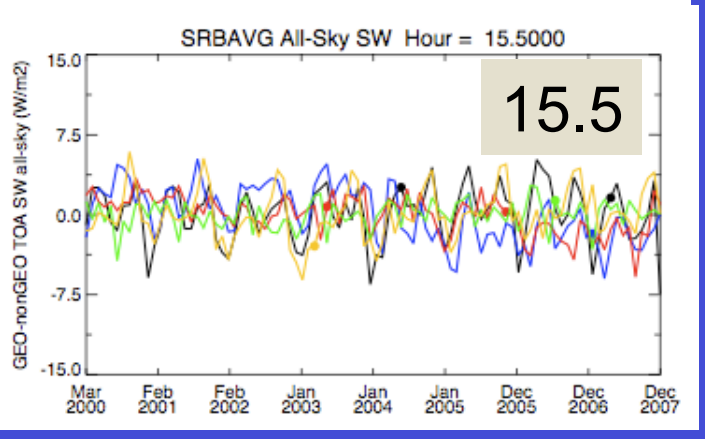


GEO-nonGEO SW deseasonalized trends by local hour

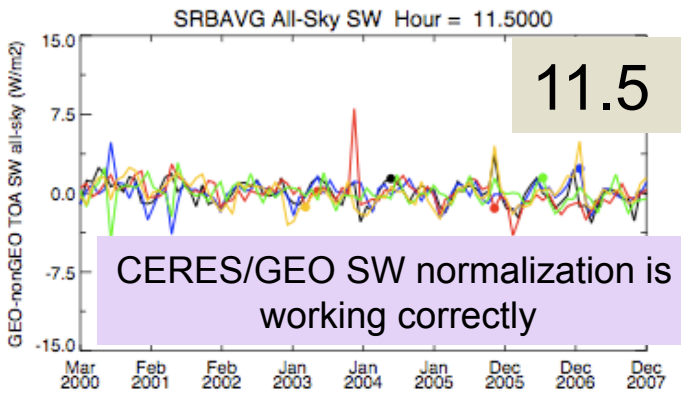




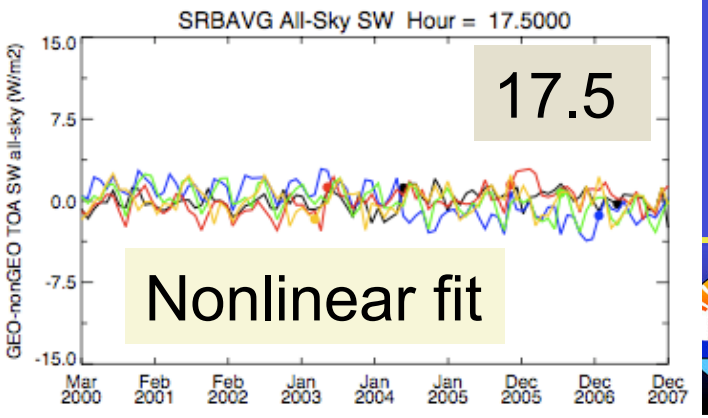




MET8
MET7
MTSAT
GOESW
GOESE



CERES/GEO SW normalization is working correctly



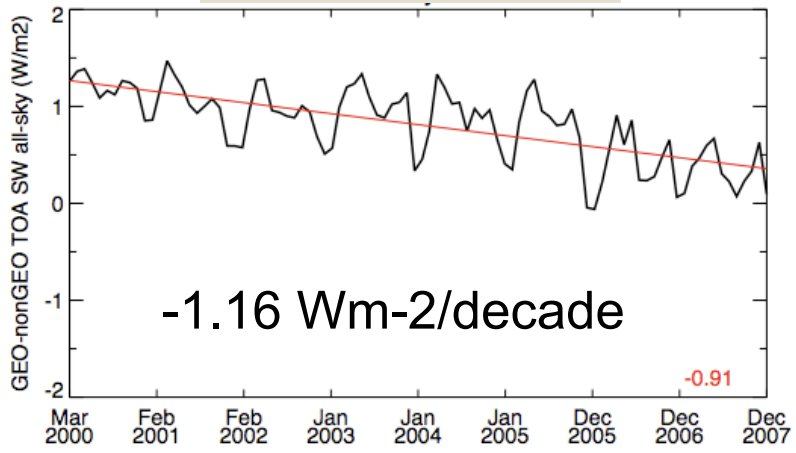
Nonlinear fit

NASA

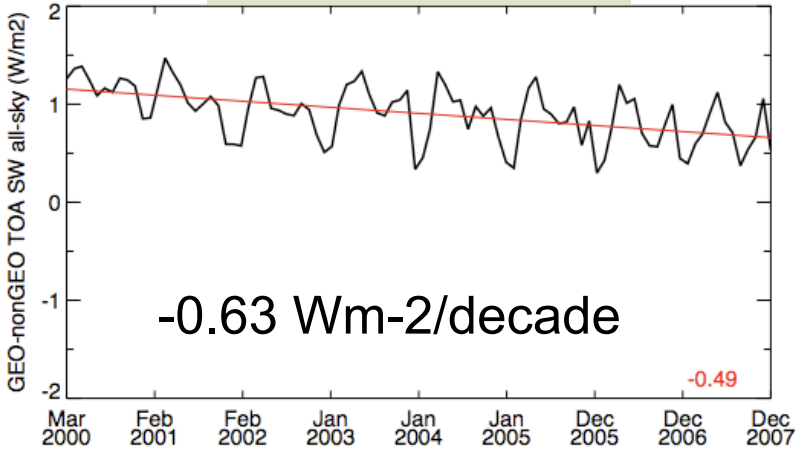
CERES

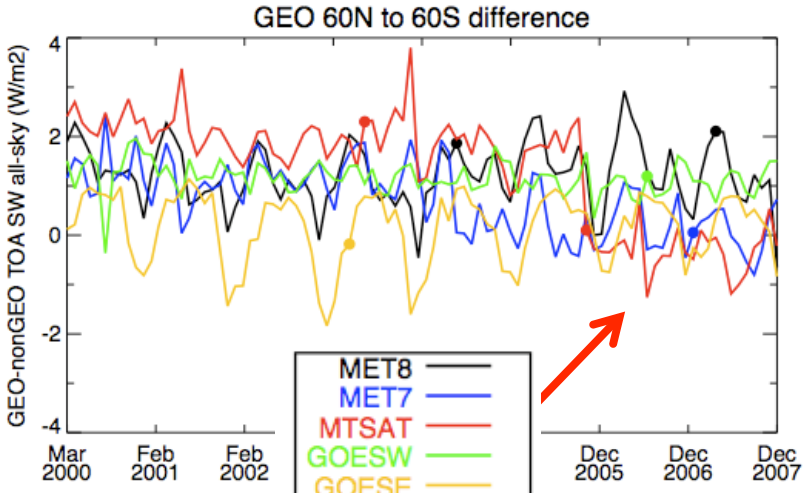
GEO-nonGEO SW trends

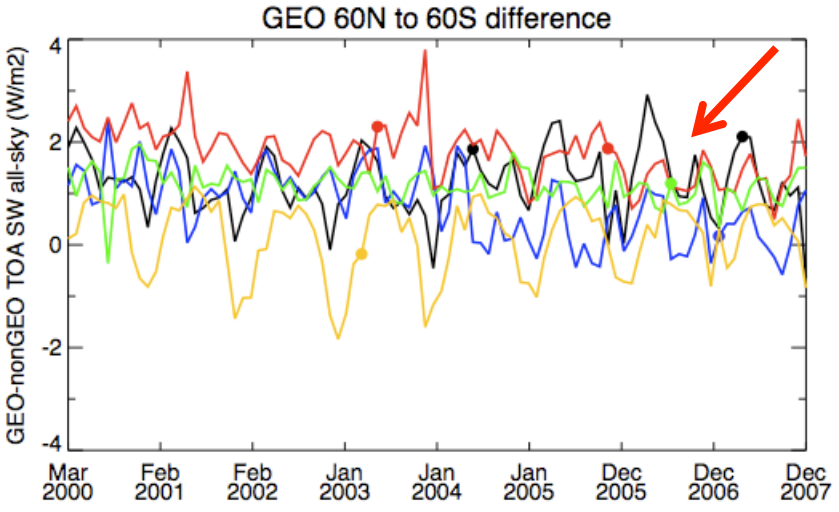
Linear Fit



Nonlinear Flt



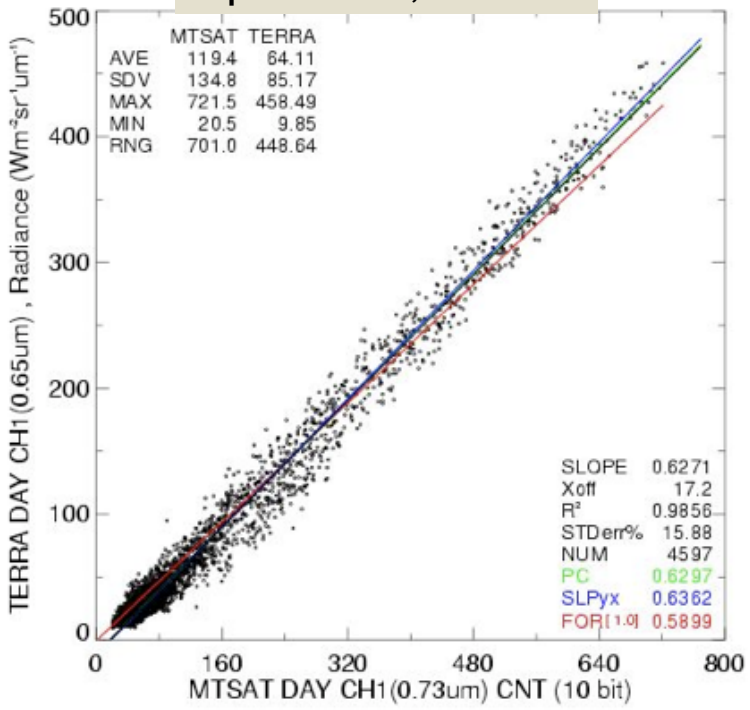




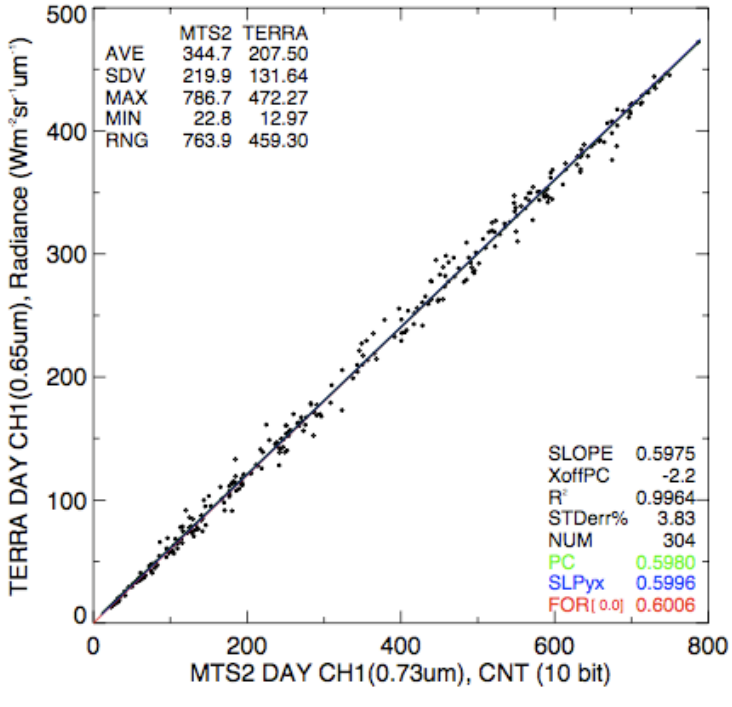
- Note improvement in SW normalization with the nonlinear MTSAT1/Terra calibration

MTSAT-1R and MTSAT-2/Terra cross-calibration comparison

MTSAT-1R/Terra
April 2008, 10-bit



MTSAT-2/Terra
Nov 2009, 10-bit

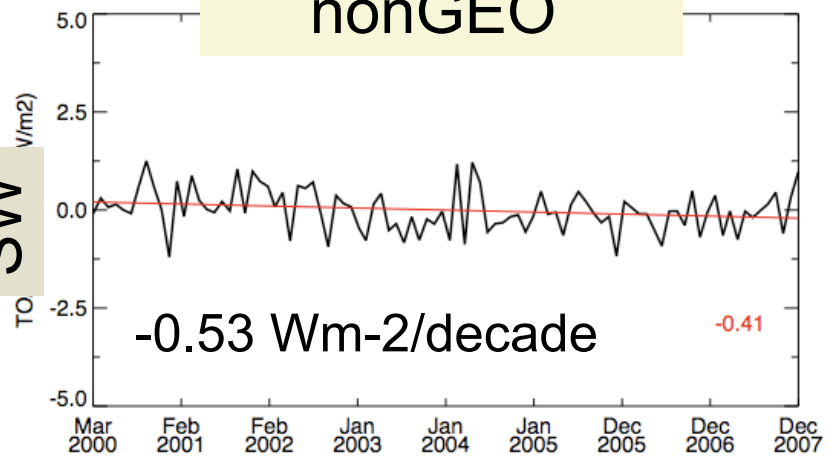


- I can now spend more time on other TISA validation activities after July 2010 when MTSAT-2 replaces MTSAT-1R as the JMA operational satellite

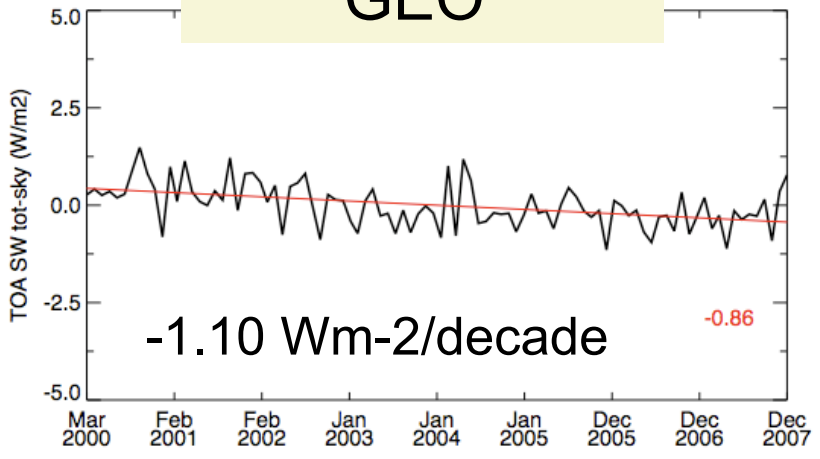
TOA all-sky global SW trend, Mar00-Dec07

SW

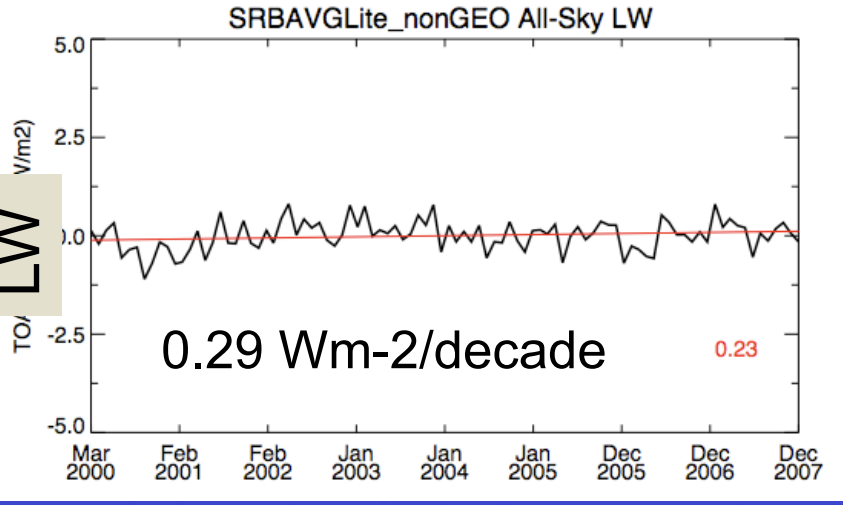
nonGEO

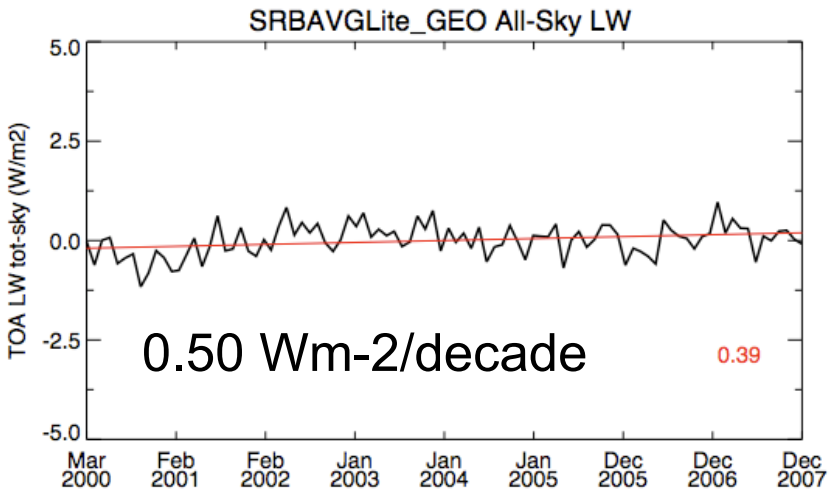


GEO



LW





- We will complete the 2008 record and reevaluate

TISA near term goals

- Release lite products as an edition
  - Verify GEO coefficients until Jan2008 to Feb 2010
  - Add in MTSAT-2 and GOES-13 satellites and hand in MTSAT coefficients
  - Add in terminator regional SW averaging and fix known bugs
- Recalibrate all GEOs to MODIS between 2000-2010 for complete time records
- Edition3 improvements
  - LW NB to BB and normalization, similar to SW, instead of instantaneous normalization
  - LW cubic spline temporal interpolation
  - GEO clear-sky maps over land, instead of MODIS, for improved GEO cloud retrievals

CERES Prototype Ordering Tool Demo

"I think it is important that NASA delivers the data to the US public, obtained with their tax dollars, in a way that are useful for greater good and do not remain confined to only a selected group. "

(User comment, August 24, 2009)

D. Doelling

NASA LaRC

C. Chu, E. Kizer, C. Mitrescu, T. Chee, E. Heckert

SSAI

CERES Tiger Team

- CERES key concept or product web pages would be explained in a few bullets with expandable pages and hyper-links for more information, instead of the DQS approach which overwhelmed the user
- Every page designed to help the user quickly decide the product for their application, user realizes there are multiple approaches to parameters

D. Doelling

NASA LaRC

J. Closs*, Z. Eitzen*, J. Gleason[a], S. Gupta*, E. Kizer*, D. Rutan*, P. Taylor[a], T. Wong[a]

**SSAI, [a]NASA LaRC*

CERES prototype tool improvements

- Load tool on newly purchased CERES web servers
  - Clean up pages and take user suggestions
  - Take down tool for a few weeks
  - Have EBAF, SSFlite, SYNlite, and ES4 online
  - Develop user product and parameter ordering statistics
  - Dynamic availability
- Develop level 3 parameter product comparison plotting package
  - Add new products as they become available as Ed3
- Develop level 2 footprint product pages
  - Subset spatially (say over a surface site) and by parameter

To try out tool

- http://www-pm.larc.nasa.gov/SATGIF1/ceres-ordering-tool/CERESExample/index.php
- User: ceres, Password: ceres-tool